

Status and Distribution of the Mugger Crocodile in Tamil Nadu

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OF THE THREE SPECIES OF crocodiles found in India, the most common and widespread is the broad-snouted mugger crocodile (*Crocodylus palustris*), also known as marsh crocodile, which inhabits all kinds of freshwater habitats such as rivers, lakes, reservoirs, hill-streams, village ponds and manmade tanks. By the late 1960s, their populations were exterminated to extremely low numbers, mainly due to uncontrolled hunting for skin trade. Habitat degradation through damming and channelling of river systems for irrigation, have caused severe fragmentation of habitats and populations throughout the species' distribution range in Tamil Nadu. Preliminary surveys conducted in 1974 and 1976 confirmed the presence of isolated populations in low densities in most of the existing habitats, considered inadequate for supporting a viable population (Whitaker, 1974 & 1976). The population in 1974 was estimated to be 200, declining to 100 in 1979, averaging 75 adult females and 25 adult males (Whitaker, 1979).

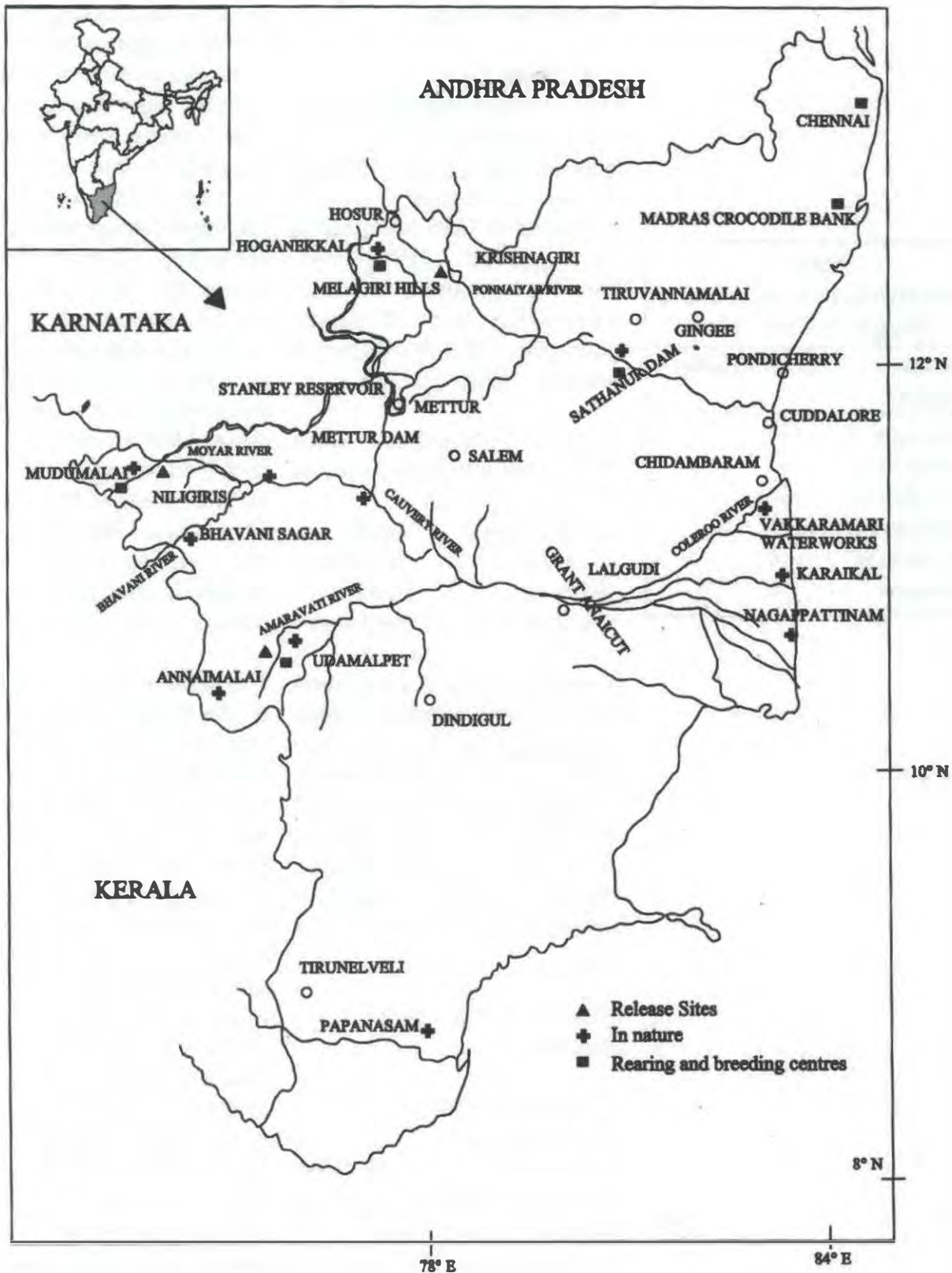
Conservation

Conservation efforts for the

revival of the species in the state were initiated in 1976 under the Crocodile Conservation Project. Under this, the state forest department set up four rearing centres. Eggs collected from the wild located within the vicinity of these centres, were successfully incubated and hatchlings reared and released in wild habitats upon attaining 1.5-2m length size. Simultaneously, the Madras Crocodile Bank Trust was set up as a major captive breeding, research and education centre for conservation of all the three Indian crocodilian species.

Reintroduction of mugger crocodiles in the different localities in the state was carried out till the mid-1980s. In 1985, habitat surveys for reintroduction of the species in the Annamalai Wildlife Sanctuary were carried out, and in 1986, 150 *C. palustris* were released at ten different sites within this protected area (Choudhury, 1985 & 1986). By 1986, a total of 372 animals had been reintroduced in six different locations in Tamil Nadu (Choudhury & Chowdhury, 1986) (Table 1). All crocodile reintroductions in the state were carried out in protected areas.

Figure 5 - Crocodiles in Tamil Nadu



However, after this, the programme ground to a halt due to lack of funds for further follow up and monitoring.

Methodology

Data and results presented in this paper are gleaned from literature, studies and field work carried out during extensive surveys conducted in Tamil Nadu during the period 1991-1993.

Methodology and animal size classes has been discussed (Satheesh, 1992; Arumugam & Andrews, 1993).

Mugger crocodiles were categorized into size-classes as follows:

- 1.5m and over - Adults
- 1-1.5m - Sub-adults
- 50cm-1m - Juveniles
- less than 50 cm - Hatchlings

In most instances, population estimates were assessed by direct evidences, and in a few cases from confirmed, reliable reports. Hatchlings have been excluded in the population counts, and the presence of nests located estimated to be the number of nesting females present in the area.

PRESENT STATUS - WILD HABITATS

Krishnagiri, Ponnaiyar River and Sathanur Reservoir

The river system flowing down from Hosur, near the Karnataka border, through Krishnagiri and Kaveripatnam, forming the Ponnaiyar River, courses through the Sathanur Reservoir in

Thiruvannamalai District and drains into the Bay of Bengal north of Cuddalore, on the east coast of Tamil Nadu. During the surveys in 1992, mugger crocodiles sighted 3 km north-west of Krishnagiri included eight adults, two sub-adults, three juveniles and 16 hatchlings. A total of 25 mugger were sighted further south-east of Krishnagiri through Kaveripatnam, comprising 10 adults, four sub-adults, two juveniles and nine hatchlings. Indirect evidence (tracks and slidemarks) estimates included five additional animals in the juvenile and sub-adult size classes. With the exception of the confirmed release of 130 animals in the area (Choudhury & Chowdhury, 1986), the results of the survey could not be compared, due to the lack of previous survey data.

The Sathanur Reservoir, is located on the Ponnaiyar River (Figure 2). Reports by local people conclude that mugger crocodiles were once common, inhabiting the reservoir area and the river, but the population had significantly depleted by the 1960s. In 1976, five nests were collected for the Forest Department's rear and release programme (Whitaker, 1976). Later, Whitaker (1978 & 1979) and Whitaker & Daniel (1980) reported 12 adults, six of which were breeding size females. A survey during the nesting season determined the population to be 30-35, including 13-15 animals in the breeding size-class. During the period 1977-1981, 1541 eggs were collected by the Forest Department for their rear and

<i>Location released</i>	<i>No. of crocodiles</i>
Krishnagiri	142
Hoganekkal	47
Annaimalai	150
Mundanthurai	21
Mudumalai	6
Sathanur	6

release programme (Vijaya, 1981).

Surveys conducted in 1993 determined the presence of 50 adults, comprising 20-23 breeding females, 12 sub-adults and 20 in the juvenile size-class (Arumugam & Andrews, 1993). Considering that no re-introduction programme was conducted in the reservoir, a comparative population estimate for the period 1977-1981 indicates a stable and upward trend in the population, thus demonstrating the view that a carefully managed egg harvesting programme is possible, with no significant impact on the population.

Hoganekkal Cauvery River System

The Hoganekkal Falls, within the Cauvery river system, is situated close to the Karnataka border on the western side of Tamil Nadu. The Cauvery flows from below the Falls, south around the Melagiri hills into the Stanley Reservoir and Mettur Dam, continuing eastward to Tamil Nadu, branching out into several tributaries before draining into the Bay of Bengal (Figure 2). During the mid-1970s, the area was estimated to have a small population of less than 10 mugger (Whitaker, 1974). During the early and mid-1980s, 47 captive reared mugger were released in the area (Choudhury & Chowdhury, 1986). However, surveys conducted during 1992 and 1993 confirmed the presence of only 15 adult mugger in this river system. The sightings of hatchling and juvenile animals indicated the presence of breeding females. Habitat assessment carried out during

these surveys determined the entire stretch to be inadequate to support a larger population and, it was concluded, most of the animals may have moved further downstream along the Cauvery, suggesting further assessment (Satheesh, 1992).

The Mettur Dam has a water spread area of 96sq. km., with most of the water being channeled out to Thanjavur for irrigation. A 1974 status report estimated the mugger population in this reservoir to be less than 10 animals (Whitaker, 1974). A survey in 1992 reported only a single sighting, and no indirect evidences of other crocodiles. Local Forest Department personnel and fishermen also report the frequent sighting of one lone *C. palustris*. The entire stretch of the Cauvery river from the Mettur Dam to Srirangam supports a large human population, where settlements and villages extend right up to the riverbanks. However, over the years, isolated sightings of mugger have been reported in the area, suggesting the possible migration of crocodiles downstream towards the Coleroon river area. Four adult mugger were sighted in 1992 at Kalannai, Grand Anaicut, a 200 A. Karikala Chola Dam, situated at the junction of the Cauvery and Coleroon rivers. Local people reported the presence of two to three crocodile near Lalgudi.

Vakkaramari Water Works

The Vakkaramari pump station consists of two major water tanks, located 5km south of

Chidambaram (Figure 3) in the delta between the Cauvery and Coleroon river systems. In the 1970s, the marsh crocodile population was estimated to be 15-20. The long distance migration of *C. palustris* from these two tanks was also reported by Whitaker (1974). In a survey conducted in 1976, 15 animals in the adult and sub-adult size-classes were reported, including the collection of three nests in the area (Whitaker & Whitaker, 1976). Surveys in 1991 and 1992 reported six mugger in the area: two adults and two juveniles by direct sightings, and reported sightings of two adults by local people, one of which was sighted in a village pond at Sivayam, 1km away from the tank (Satheesh, 1992).

The Moyar River System and Bhavani Sagar Dam

The Moyar river courses down the Nilgiri peaks through the Mudumalai plateau and Wildlife Sanctuary, up to the Moyar Gorge between Tamil Nadu and Karnataka, before finally draining into the Bhavani Sagar Dam, from where it join with the Cauvery river (Figure 2). This river system was comprehensively and systematically surveyed over various seasons between 1991 and 1993 (Satheesh, 1992; Andrews & Arumugam, 1992). The Moyar stretch between Thorapalli and Teppakadu was surveyed by the author in 1993. Six adults over 2.5m in size, two juveniles and 19 hatchlings were sighted. A group of 11 hatchlings were sighted near Kargudi, and

another group of eight sighted 1km west of Teppakadu, indicating the presence of at least two breeding females in this stretch. Several follow-up surveys revealed the presence of six animals, including hatchlings in varying numbers. However, the habitat is prone to human-induced disturbances, making this small, pristine 3.8km stretch inadequate to support a larger population. The entire stretch of the river in the Moyar valley from the Power House right up to the Bhavani Sagar Dam, including the Kaderhalla and the Segur rivers that flow down into the Moyar, was surveyed in 1992 and 1993.

The Kaderhalla is not a perennial river but contains two pools inhabited by two females, which nest annually in the area. Both females were identified during the survey, including sightings of hatchlings and three juveniles. However, the rest of this river system is heavily silted, practically drying out in the summer months (Andrews & Arumugam, 1992). During the surveys in 1976, three nests were located and the total population was estimated to comprise six breeding females (Whitaker & Whitaker, 1976 & 1977). The perennial Segur river that drains into the Moyar river, is inhabited by two to three breeding females. Hatchlings and two juveniles were also sighted.

Intensive surveys from the Kolkombe Power House down to the Bhavani Sagar Dam revealed a total of 94 *C. palustris* along this stretch, which included 54 adults.

Final estimates through direct sightings and excluding hatchling counts, puts the total population of adults, sub-adults and juveniles at 178 in the Moyar system (Table 2). This suggests that the Moyar valley is definitely one of the last pristine *C. palustris* habitats in Tamil Nadu, with a viable and stable population of crocodiles. Other survey observations and habitat assessments establish that this area encompasses a fairly rich ecosystem of faunal diversity (Andrews & Arumugam, 1992).

The Bhavani river which drains into the Bhavani Dam, consists of five pools, 20 km west of Mettupalayam, where there are at least three breeding females. Hatchlings and yearlings have been sighted in this river. Hatchlings and juveniles are also often found in the fish breeding and rearing tanks of the Fisheries Department. During the surveys conducted in the Bhavani Sagar Dam in 1991 and 1992, two-three adults, seven juveniles and three sub-adult animals were sighted, suggesting migration of juveniles and sub-adults from the Moyar river into the dam. The area was surveyed during two nesting seasons. A single nest was found in 1992, which contained a two-day old clutch of 38 infertile eggs. The intensive fishing activities in the dam and agriculture in the surrounding area makes the habitat unsuitable for crocodiles.

Amaravati Reservoir and Annamalai Wildlife Sanctuary

The Amaravati reservoir, with an area 9.31 sq. km, is situated in the

Indira Gandhi Wildlife Sanctuary. Several large streams, namely, the Chinnar, Thenar and Pambar drain into this dam, and thereafter continue as the Amaravati river, finally meeting with the Cauvery.

The Amaravati reservoir was reported to contain the largest *C. palustris* population in Tamil Nadu, supporting 25 adults, including 12 breeding females (Whitaker & Daniel, 1980; Whitaker, 1979). In 1974, 22 animals were recorded during a night survey, 14 adults and 11 nests during a day-time survey (Whitaker & Whitaker, 1977). In 1983, 15 nests were reported, and the population was estimated to be 50, including all size-classes (Davidar, 1983). Subsequently, a total of 38 adults were reported and several more adult animals in the Chinnar river (Satheesh, 1992) (Table 2). During a nesting ecology study in 1994, only five nests were found. The low nesting intensity around the reservoir was attributed to the change in the habitat over the years. Subsequently, eight nests were located along the stream habitat (Vasudevan, 1997). The total population for the reservoir, including the rivers that drain into it, is currently estimated to be 60 adults and 37 sub-adults.

Upper Aliyar Reservoir

This small reservoir is located in the Annamalai hill range of the Western Ghats in the Annamalai Wildlife Sanctuary. Although historically it is outside the distribution range of the species, 20 captive-bred animals were released in the area in 1985

Table 2
***Crocodylus palustris* population structure in different locations in Tamil Nadu**

<i>Location</i>	<i>Adults</i>	<i>Sub-adults</i>	<i>Juveniles</i>
Krishnagiri- Ponnaiyar River	18	6	10
Sathanur Dam	50	12	20
Hoganekkal	15	4	5
Mettur Dam			
Cauvery River	1	-	-
Kalannai, Kilikudu-	14	2	-
Grand Anaicut, Coleroon, Lalgudi, Vakkaramari			
Moyar River system, Bhavani Sagar Dam, Bhavani River	65	43	86
Amaravati Sagar Dam area	48	17	18
Upper Aliyar Reservoir	16	-	-
Mundanthurai			
Tambaraparani River	15	-	-
<i>Total</i>	<i>242</i>	<i>84</i>	<i>139</i>

(Choudhury, 1986). By 1992, only 16 individuals still inhabited the area, mostly in the 1.5-2.5m size-class. Surveys and assessments determined the lack of suitable nesting habitat (Satheesh, 1992).

Mundanthurai-Kalakkad Wildlife Sanctuary

The Tambaraparani river was dammed at Karayar in Mundanthurai, in the Kalakkad Wildlife Sanctuary. Further downstream, the river is dammed at Papanasam. Four animals were sighted during surveys in 1992 (Satheesh, 1992) and another three animals in 1993 (Ali, *pers. comm*). In 1986, 21 captive reared animals in the 2-2.5m size-class were released in Mundanthurai, which are likely to have dispersed along the river, suggesting further

assessment (Satheesh, 1992). The present estimated population in this system is 15 adults.

STATUS - CAPTIVITY

Sathanur Crocodile Centre - The Sathanur Crocodile Centre, situated 40km south-west of the pilgrim town of Thiruvanamalai was established by the Tamil Nadu Forest Department in 1977 for purposes of crocodile reintroduction. A total of 185 eggs were collected from the wild, hatched and the animals reared for the Centre's release programme. At present, the Centre has a stock of 444 mugger crocodiles, mostly comprising animals of the breeding size-class, housed in 30 enclosures. The facility is well maintained by six staff appointed

by the Forest Department. A breeding programme is underway. However, no records are being maintained and animals of different size-classes are housed together. Size-sorting the animals in different groups is urgently required for facilitating better growth rate. Feed comprises beef and bones, supplied every alternate day (Kailas, 1999).

Tourists who visit the Dam also visit the Crocodile Centre and are charged a nominal fee of Re 0.50 averaging a monthly income of Rs.25,000/-. The cost of feed amounts to Rs. 22,000/- per month. It is recommended that an increase in entrance fee to Rs.2/- per person, would help recover the cost of maintaining the Centre and for further developing the tourism facilities.

Amaravati Sagar Crocodile Farm

Established in 1975, this is the largest government rearing station. Eggs collected from the perimeter of the Dam are hatched and reared at the Farm. Several of these animals have been reintroduced into the wild (Choudury, 1986). Females hatched in 1975 and 1976 began breeding in 1983 (Davidar, 1983). Currently, 430 animals are maintained in captivity, most in the adult size-class. Three Forest Department personnel manage and maintain the Centre, under the overall charge of a Range Officer (Kailas, 1999).

Masinagudi Rearing Station

The Masinagudi Crocodile Rearing Station is situated on the edge of

the Mudumalai Wildlife Sanctuary. The rearing station has a total of 30 adult animals, maintained by a staff of three belonging to the Forest Department staff. The entire group are from eggs and hatchlings collected along the Moyar River system.

Hoganekkal Rearing Centre

The Hoganekkal Rearing Centre was started in 1975. Since then, 130 animals from this station have been released into the Krishnagiri and Ponnaiyar river systems in the late 1970s and early 1980s. A total of 190 mugger crocodiles are being maintained here, comprising mostly adult animals. Currently, the Centre is faced with the problem of overcrowding of animals in enclosures.

Madras Crocodile Bank Trust

The Madras Crocodile Bank Trust, located 50km south of Chennai on the Coramandel Coast was established for the conservation and study of India's three crocodilians: the mugger crocodile (*C. palustris*), the saltwater or estuarine crocodile (*C. porosus*) and the gharial (*G. gangeticus*). Since its inception, the Bank has carried out extensive research on crocodilians both in captivity and in wild habitats. Starting with a few adults and about 30 hatchlings, the Bank has been extremely successful in breeding all three species, including seven endangered and exotic crocodilians species maintained in captivity. In addition, the Bank has witnessed the successful breeding of F2 and F3 generation mugger crocodiles in captivity. Over 900

Table 3
Number of *Crocodylus palustris* held in captivity in the different project centres in Tamil Nadu

Name of Centre	No. of Crocodiles	Remarks
Sathanur Crocodile Rearing Centre	444	Mostly adults, reported breeding in 1980s
Amaravati Sagar Crocodile Farm	430	-do-
Hoganekkal Rearing Centre	190	Mostly adults
Masinagudi Crocodile Rearing Station	30	Adults, mostly an
	stunted and in	unhealthy condition.
Madras Crocodile Bank Trust	2,802	Mostly adults

animals have been supplied for restocking and breeding programmes of the various State Forest Department in the country and to zoos in India and abroad. The resultant stock pile up from the tremendous breeding success, and the halting of further restocking activities in the country in 1984, forced the Bank to terminate the breeding of *C. palustris* in 1992. Currently, 2802 *C. palustris* of various size classes are maintained here, of which 1173 are adult and sub-adult animals, and the remainder juveniles (Whitaker & Andrews, 1992). A drastic move is on to offload the existing surplus stock to Indian and foreign zoos, so as to reduce the mortality rate of animals due to overcrowding and the high maintenance costs.

Discussion and conclusion

Despite the enormous pressures encountered, particularly from habitat loss and human encroachment, conservation

efforts for the survival of *C. palustris* in Tamil Nadu have been notably successful. Surveys and assessments carried out in 1991 and 1992 indicate that *C. palustris* populations are stable only within protected areas. A drastic decline in mugger populations was observed in areas prone to severe human pressures, mainly due to habitat alteration and fragmentation. Reduction and degradation of crocodile nesting habitat and poaching of eggs, has affected populations. Dispersal and migration of sub-adult and juvenile size-class animals into human habitation where their chances of survival is further reduced, poses another problem. There is an urgent need to implement the management plans drawn up in 1993 and 1997, and of continued monitoring and initiation of a sound environmental education programme for people living in and around crocodile habitats.

Studies conducted during the same period also indicate that the constantly changing manmade or altered habitats are inadequate to sustain larger and viable populations. Some of the major factors that have had an affect on mugger populations include the silting up of dams over the years, decrease in depth and increase in water spread area. The reduction in water levels and drying up of streams and dams during the summer months have taken their toll, causing fish populations to die out and dispersal of mugger crocodiles to unfavourable habitats, in most cases human habitation, where their survival is at risk and re-migration is next to impossible. The increase in water spread area causes further damage and reduces nesting habitat area, as indicated from observations made at sites such as the Amaravati and Bhavani Sagar dams (Davidar, 1983; Satheesh, 1992; Andrews & Arumugam, 1992; Vasudevan, 1998). Findings indicate that the carrying capacity in altered habitats is limited, with little or no chances for a viable recruitment rate and dispersal for juveniles and sub-adults. Other problems affecting altered habitats is the intensive fishing and agricultural activities around these areas, including the frequent use of fertilizers and pesticides by local settlers, aggravated by the ever-increasing human habitation in these areas.

Extensive studies conducted in the Moyar river strongly suggest that it is the last-remaining pristine habitat suitable for the future

conservation and survival of mugger crocodiles in Tamil Nadu. Considering the total mugger population and the extent of its habitat, the pressure is considerably lesser here than in other areas, as it falls within a protected sanctuary zone, thus providing for a well-managed conservation programme, with minimal cost and effort.

State-wide surveys and habitat assessment results confirm the status of *C. palustris* as follows:

- a) Most *C. palustris* populations in the state are fragmented.
- b) Stable populations are restricted only to protected areas.
- c) Populations in protected areas and in dam sites have reached saturation limits.
- d) There is distinct lack of area for further dispersal within protected areas and no viable habitat outside protected areas, in particular for juvenile and sub-adult size-classes.
- e) Small, fragmented, populations consisting of a few individuals existing outside protected areas, cannot provide future viable populations due to the relative destruction and disturbance of their nesting habitat resulting in low survival and recruitment rates.
- f) Results of habitat assessments suggest lack of suitable habitat for further restocking or reintroduction of *C. palustris* in Tamil Nadu.
- g) Altered habitats like dams are not optimum habitat for *C. palustris*.
- h) Stock piles of surplus *C.*

palustris in the five centres have become a tremendous burden on resources and space.

Tamil Nadu was the only state in the country, appointed to review and conduct a pilot study for farming of *C. palustris*. The proposal needs to be revived, reviewed and a feasibility study urgently implemented. A proposal for a one-time cull, should be considered, in order to ease the present problems faced in these captive centres.

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